STUDIES

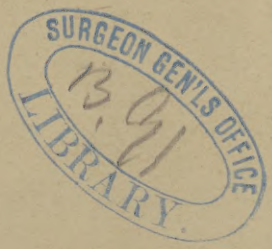
OF AN

EPIDEMIC OF DIPHTHERIA,

WHICH PREVAILED AT FERRISBURG (ADJACENT TO VERGENNES), VT., DURING THE SUMMER OF 1877.

BY

HENRY I. BOWDITCH, M.D.,
MASSACHUSETTS.



EXTRACTED FROM THE
TRANSACTIONS OF THE AMERICAN MEDICAL ASSOCIATION.

PHILADELPHIA:
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I WAS upon my usual summer vacation at Ferrisburg, on the borders of Lake Champlain, when rumors came to me that a very virulent epidemic of diphtheria had broken out and was locally and fatally prevailing within a small area of the adjacent country, chiefly among the school children, and it was also said to attack principally, if not wholly, those who drank of a certain well, which had been long disused. I deemed it an opportunity for studying the disease, limited as it was to a small country district, which should not be lost. I spent three days in the investigation, and although I shall be unable to give you any new and striking results, the examination was of great value to myself. I present it not certainly as a specimen of a perfect investigation, but simply as an illustration of what I think each one of us ought to do, according to his opportunity and ability, in any similar case, viz., accurately record the facts, and endeavor honestly to deduce laws therefrom.

During my examinations I entered all the houses of the district, to which the epidemic was chiefly limited. The dates of said visits were August 28, September 4, and September 26, 1877. The first time I went in an open vehicle, accompanied by four physicians from Vergennes, who had attended all the sick except those of one family, which had been seen by a homœopath. I was alone at my two subsequent examinations. During these three days I not only visited all the houses, but I conversed with many persons, and also had the invaluable aid of these attendant physicians. I talked with individuals whose families had suffered, and also with others whose homes had escaped. From these various sources I was able to get the facts and statistics I shall give. I believe that the information on both of these points is substantially correct, although to the adult

statistics I think that probably a few more should be added, viz., the adult laborers. The numbers of children and of adults immediately connected with the families are exact. The majority, if not the whole, of the population were farmers, and did their own work. A few had hired assistants. I am not sure of the exact number of these last. This doubt does not materially vitiate the result. If the number were augmented the fact would bring out more conspicuously, than with the present data, the very different liabilities to the disease of childhood and of adult life. Let us now proceed to the more minute study of the locality and course of the epidemic.

LOCALITY.

The epidemic was limited almost precisely to a space included within a rectangle, one and three-quarters mile long by three-fourths of a mile broad. The country is generally flat or but slightly undulating, and was evidently a part of the ancient bed of Lake Champlain. A sluggish, winding river runs through it into the lake. A line, drawn diagonally across (see map) the district, would divide it geologically into two distinct formations, that towards the lake being gravelly, with a firm clay beneath, while on the other part the clay alone rises to the surface, or it is mixed with a little gravel. The epidemic prevailed equally upon both sides of this line.

CHARACTER AND NUMBER OF THE HOMESTEADS.

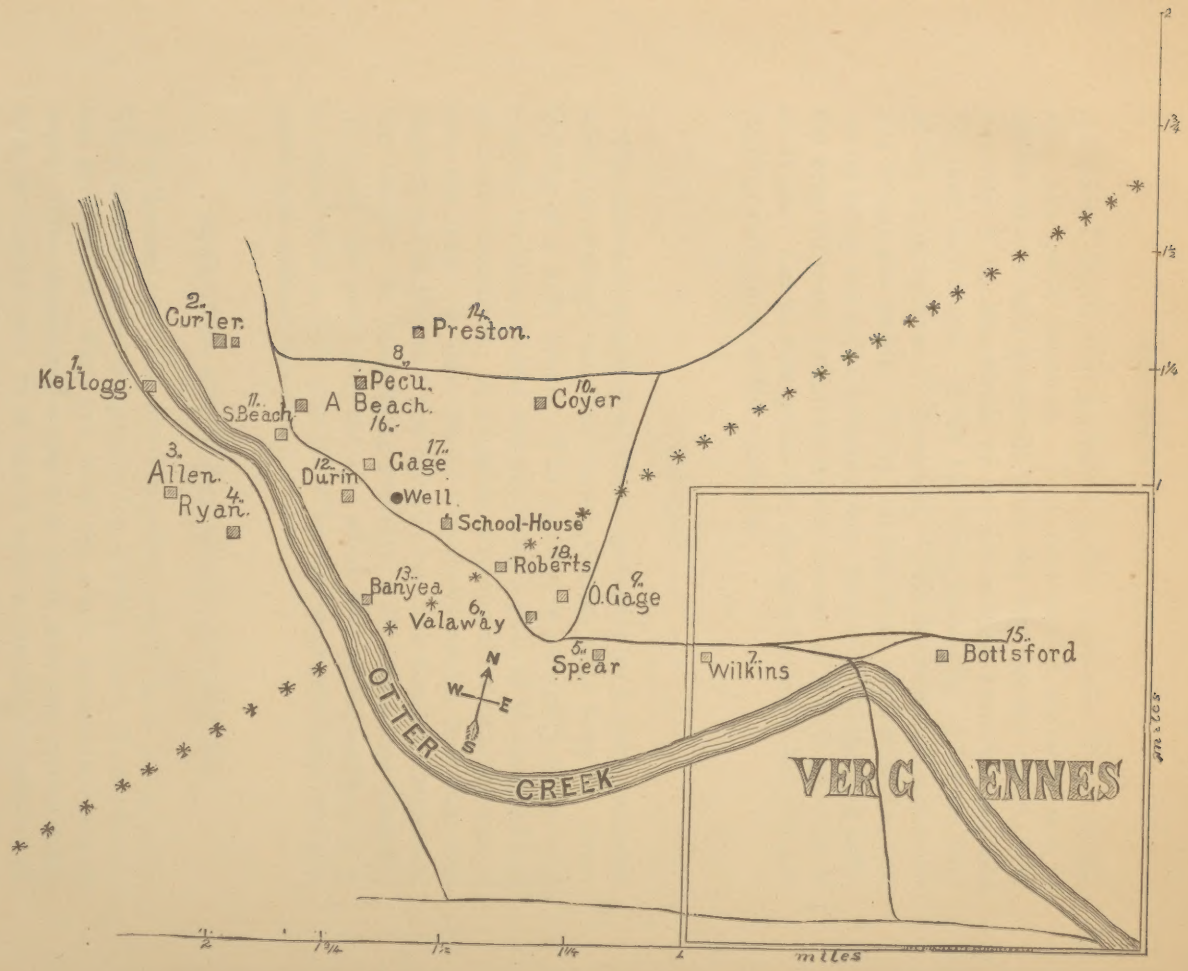
The houses are with one exception simple farm homesteads. They all stand directly upon, or but a little above, the surrounding greensward. They are, with the above exception, built of wood. The exceptional house is of brick, and two stories high, with an L attached. It is raised upon a granite foundation, at least a foot and a half above the soil. It has also a well-cemented, capacious cellar for vegetables, etc. It stands in an open field without any neighbors very near to it, but it is about in the centre of the epidemic district. Here the disease was most fatal.

There are only nineteen houses in the district, and in sixteen of them occurred diphtheria in some form, either as a mild sore throat, or as a violent membranous diphtheria, or as both conjoined. In one of the three houses, where the disease did not

Map of a part of the town of Ferrisburg, Vt., illustrative of the course of an epidemic of diphtheria in 1877.

The numbers show the various houses in the district.

Soil at the north of this (* * *) line is chiefly gravelly, or clay mixed with gravel; that at the south is clay.



appear, there were two children, but the whole family were purposely kept away from any house where the epidemic prevailed. In the other two houses there were adults only, but these adults did sometimes come in contact with the disease, while helping the sick.

Concerning the residents in these nineteen homesteads I found the following facts:—

WHOLE NUMBER OF INHABITANTS IN THE DISTRICT.

	Adult members of families.	Adult hired assistants.	Children.
Total	43	3[1]	57
Number attacked	6	.....	49
Percentage of sick	13.04	.....	85.96
Total deaths	1	.....	14
Percentage of deaths { to population	2.32	.....	24.55
Percentage of deaths { " whole number sick	16.66	.....	28.57

Remarks on the Table.—We see at a glance from the table the much larger number of children, compared with adults, who were taken sick, viz., more than six times as many. And of the deaths to the whole population, the percentage of children killed was more than twelve times greater than that of adults; the percentage of deaths to the whole number taken sick, was not quite double among children what it was among adults.

THE GRADUAL PROGRESS OF THE DISEASE.

The map which accompanies this paper is a copy from an official county map. I have marked by numbers the separate homesteads, save one in which there was no disease.

The first case of diphtheria, which had occurred in the neighborhood for over a year, was that of a boy named Kellogg, house No. 1. He was taken ill May 7, 1877. He resided on the side of the river opposite to that which bore the main brunt of the epidemic. He had daily rowed across the river to attend at the common school in the centre of the district. He was in the family of the Poor-Farm keeper. This poor-farm house was very

[1] This, as I have already stated, may be too small a number; but only a few more, if any, should be added.

like all the rest of the houses in the district. It was built of wood, but little above the soil; and in its surrounding, had the usual air of unneatness, observed around most New England farm houses. Immediately behind it, was a smaller building for a few of the town's poor. I regret now that I did not examine, more critically, these premises where this first case arose.

In May, 1878, I received the following letter from Dr. Kidder in reply to one I wrote asking for a more detailed examination of it: "I visited the almshouse, and I find nothing of importance unsanitary, unless it be a spring of water in the cellar containing, at present, some surface water which has drained into it and which has been uniformly neglected. It has an outlet some three rods from the house, discharging, at present, freely. Under a part of the house occupied by the paupers is a hen-house, and though the keeper assures me to the contrary, I am satisfied that it has been much neglected in regard to cleanliness. It is perfectly dry, and free from moisture. Five rods from the house is a marsh, which is, at times, dry but generally it contains stagnant water. The privy is ten feet from the house and cleansed, I am told, once a year. They use for all purposes river water, taking it from a sort of bay where the water moves, if it moves at all, very sluggishly; soil, sandy loam, or sand with clay bottom." . . . With such facts on record we cannot say that the sanitary condition of the premises in which the first case occurred was good, though perhaps it was not worse than most of the family residences in the district.

The boy was taken sick May 7, while going from school and became so weak that his companions of the Curler family (No. 2) helped him to get home. He died in ten days, May 17. All the children of this Curler family and of the Allen (3) and Ryan family (4) subsequently had mild sore throats, but none had the severer symptoms of diphtheria. Allen and Ryan lived on the same side of the river as No. 1. None died. The children attended school afterwards, and mingled with their playmates up to July 28, seventy-two days, when Spear (No. 5) was taken ill.

(No. 5) *Spear* may be said to mark, by his sickness, the commencement of the second and severer period of the epidemic. It was just sixty-two days after Kellogg (No. 1) had died. Spear's sister was the teacher of the school. She informed me that, for some time previously, she herself had not felt quite well, and many of the scholars had been variously affected, some with

giddiness and malaise, and some with nausea and even vomiting. Under these circumstances, the school was forthwith closed, on her brother being taken ill. Spear recovered.

No. 6. The *Valaway* family was taken the next day, July 29. Five (5) out of seven (7) children were severely affected with true diphtheria, and two died within a short time. Of the two who escaped, one, a boy about eight years old, was taken violently with the complaint September 25, *i. e.* fifty-nine days after the rest of the family had it, and long after the disease had apparently left the house. He had never been separated from the other children, while they were ill. But he remained untouched by the disease and seemed well till taken down at this later date. There is thus a strong analogy between the periods intervening between his brothers' and sisters' illness and death and his own, viz., fifty-nine days, and that between the Kellogg and Spear cases, which was seventy-two days. But we may suppose that the malign influence, whatever that may be, was more constantly and closely in contact with the Valaway boy, because he was resident in the same house with those who were ill, than with Spear, who came in contact with the disease perhaps from some unknown fellow pupils at school, or from some equally unknown malignant atmospheric influence, that gradually spread over the district.

No. 7. The *Wilkins* family were next attacked August 3, five days after Spear (No. 5). Four had the disease and all recovered.

No. 8. Next came the *Pecu's*, with seven children in the family. Four of them attended school. All, except a nursing babe, were ill, and three died. The first was taken August 4th or 5th, *i. e.* five or six days after Spear.

No. 9. *Orange Gage's* family lived in the only brick house in the district, situated in a large open field. I have already alluded to it as, *seemingly*, the best house in the district. The first child became sick August 6, *i. e.* eight days after Spear (No. 5). The three children and their mother all died. We shall hereafter study more particularly this homestead.

No. 10. *Coyer*. This family had three young women in it. They were too old to attend school, but their mother had daily gone to nurse the Pecu family (No. 8) during their illness. She was taken ill August 14—about ten days after the first of the Pecu (No. 8), seventeen days after Spear (No. 5). The three daughters were successively seized August 17, 19, and 28. All recovered. This family's illness marked a lull, so to speak, in the severity of the

epidemic. At my first visit, August 28, I saw all three girls still suffering, one pretty severely. The last was sitting up. She had a thin diphtheritic membrane on the tonsils, but constitutionally was not very ill.

At my second visit, just one week afterwards, I found:—

No. 11. *S. Beach.* The mother and daughter had been at Pecu's during the illness of the family. The daughter had had severe local and constitutional symptoms, and a little brother had, at the time of my visit, slight membrane upon the tonsils. Both recovered.

No. 12. *Durin.* At my first visit, none had been ill, though the little boy had been at the school. At my second visit, I found this little fellow somewhat suffering, but able to walk about. A membrane was on the tonsil. He got well.

No. 13. *Banyea.* This family resided at a short distance from the others. The children and mother had kept away from the places of sickness. But the mother said to me "two or three weeks after all illness seemed to have left the Pecu house, I allowed one of my children to go there to see their playmates; I thought there was no danger." In consequence, as she believed, of this visit, the child was taken ill, and, afterwards, probably from her, the disease took seven of the eight children; the one who escaped was a nursing babe. One child died.

No. 14. *Preston.* This family the mother had specially guarded from danger. She had herself avoided all her neighbors' houses, and had prevented her children from going to them. They had however attended school, but had avoided using the well water, which had a bad reputation for its impurity. As their mother had given them milk to carry to school to drink, and as they were not ill while all around were suffering, common rumor asserted that they had escaped, because they had avoided the water. We shall hereafter see how false that idea was. At my second visit, and before a chemical examination of the water was made, I was interested in seeing this perfectly healthy family of children and mother, equally robust. At my third visit Sept. 28, I learned that on September 10, forty-four days after Spear's (No. 5) attack, the physician was called to one child. In a very brief space of time all, with the mother, had the disease. All the children (4) died. The mother was broken by disease, at the time of my visit, and had evident paralysis of the palate. The father had assisted in laying out one of the Pecu children. He had

attended many of the funerals. He told me that he feared he had carried the disease home to his children and to their mother. I would remark that this house, like Banyea's (No. 13), was a little more towards the outside of the infected district than others.

No. 15. *Bottsford.* The house in which this family lived was on the top of a small, apparently dry, hilltop overlooking all the country round. The house was of wood, but looking better than most of the others. Everything outside and inside of it had the air of perfect neatness. The mother and children were cleanly dressed. Even the filthy habit of throwing slops at the back of the house could not be as offensive as in most of the others, because the liquid portion tended to run very rapidly down the hillside on which it fell. The spot where the slops fell, however, presented the usual white aspect, and was rather moist and destitute of grass. I perceived no unpleasant odors about the premises. All the children had sore throats between my second and third visits. One evidently had diphtheritic membrane, at my third visit. All recovered perfectly. The house was further than any other from the centre of the district, and the children attended another school, and associated only with the pupils of the school at Vergennes. The father, however, had worked for Orange Gage (No. 9) while fatal sickness prevailed in that family; and although he did not enter the house, and was never ill himself, it is possible perhaps, as suggested by Mr. Preston in his own case, he was the medium of communicating the complaint to his own children.

There were four more families, one of which, No. 16, *A. Beach*, had one child with a slight sore throat. The father attended the funerals, the mother avoided the sick. The three last, viz., No. 17, *Gage*, No. 18, *Mr. Roberts*, and No. 19, *Mr. E. D. Roberts*, had only adults in the family. These adults helped, at times, those who were sick, but had no diphtheria in their homes.

I have thus endeavored to give you an idea of the general course of the epidemic. I regret to admit that I have gained no real knowledge of its *first cause*, although you may have already had some hints as to my views of its mode of propagation from one person to another. I am not aware that modern investigation has as yet discovered how diphtheria arises. The cause of the first case, Kellogg's (No. 1), remains unknown. No diph-

theria had occurred in the country round for many months, beyond a year. But let us, if possible, see how the disease propagated itself. After it had suddenly and fatally struck Kellogg's (No. 1) it lay, as it were, almost dormant, only producing mild sore throat in three families immediately adjacent, two on the same side of the stream. They were the Nos. 2, 3, and 4. Some of the children, it will be remembered, helped the sick boy on his way home from school. After this, it smouldered, so to speak, mingling probably, however, on the playground and in schoolroom with all the children of the district. Perhaps it was its influence which, while not producing the specific diphtheritic trouble, was really disturbing the health of scholars observed by the teacher. Finally, after this long rest it broke out furiously, just two months after Kellogg's death, and raged for three weeks. Then apparently came a lull, broken again by the deaths of the Preston (No. 14) family, who had escaped during the earlier part of the epidemic.

During all these terrible weeks, contact one with the other is seen evident in many cases, with, however, some strange exceptions of delay in manifestation of the deleterious influence, whatever that was. Contagion, in other words, is written imperfectly but apparently evidently in connection with its progress. And when that seeming cause fails, we have infection by means of some member in the family either carrying it in his or her own diseased person (Coyer), or still more singularly, as in the Preston or Bottsford families, possibly carried by the fathers to the children, while they themselves remained unscathed. This, as we have seen, was apparently done with most fatal effect by Mr. Preston, but less severely, though as generally to all his children, by Mr. Bottsford.

Now we cannot absolutely affirm that our facts prove that contagion and infection are the means of propagating the disease. But as modern scientific medicine I believe generally tends to show the contagious and infectious nature of diphtheria, this small compact apparent prevalence of it may confirm this view.[1] But

[1] In connection with the idea of contagion I cannot forbear quoting again from Dr. Kidder's letter. It appears that a girl, a domestic in one of the families during the prevalence of diphtheria (No. 6, Valaway, in which five out of seven were sick and two died), "subsequently went to service in another family, where two weeks afterwards they lost two children with the disease. She then went to a distance of four or five miles in another and opposite direction, where the disease

are there not other lessons of warning to be gathered from this epidemic? Did filth have any effect upon the severity of the disease? I think the different facts occurring in three families seem to indicate that filth, and by that I mean a filthy atmosphere, or soil surrounding a house, had a most deleterious influence, making the attacks more severe and more fatal; while a cleanly surrounding had a good effect, and perhaps made the disease less fatal. Compare Orange Gage's house with the Bottsfords'. The former is, as we have seen, the best looking house in the district, the only brick one, and it is situated in an open field removed from neighbors. It is on a plain, and the slops are thrown into a drain, whose mouth opens directly at the back door, and they are thence carried to a bog where cattle stand. Hence the smell of decomposing slops, mixed with those of the feet and the renal and intestinal excreta of cattle, and the malaria from the bog, are really *conducted into the house.* Observe the folly of this plan. Arranged for neatness outside of the homestead, it quadrupled, by its ingenious contrivance, the real filth which was breathed by the inmates. Three children with their mother were slain. The Bottsfords' house is on the hill-top, and is open to every breeze. The slops are conveyed rapidly down hill. Everything is neat inside and out of the house. Four children had the disease mildly, only one had a little membrane in the throat. All recovered. One cannot assert that these two houses *prove conclusively* the evil of filth and advantage of cleanliness, but knowing what modern sanitary science says of the great influence of filth in increasing various diseases of a similar contagious and infectious character, we may at least be permitted to say that these two houses and their surroundings illustrate the idea underlying the belief in a filth aggravation of disease. Let us now see what our facts teach in regard to the effects of contaminated water and milk, during this epidemic.

I have already stated that, before I began my investigation, the

had never been. After a few weeks, this family also lost two children while she was there." Lately, say three or four weeks ago (*i. e.* April, 1878), "she was employed in a family, where everything is kept in a perfectly cleanly condition, but no especial cause (except her presence may have been, I think, a sufficient one) for the occurrence of diphtheria, and yet two cases appeared." The cases were not severe and the patients recovered. Certainly contagion and infection seem to have had potent influence during the peregrinations of this servant.

common rumor was that the disease arose from drinking the water of a long disused well, and it was said that those children who drank it had diphtheria, but those who did not drink it escaped.

The Preston family, for example, by the care of their mother, carried milk to school and avoided the water; hence it was said they continued well, while others died who used it. I heard too, that the water "smelled badly," that "it had scum over it." All these statements were merely the vagaries of public rumor.

I visited the well with my companions, the physicians, and one of them, the eldest of the party, drank a tumbler of it to prove his disbelief in that theory. It had a perfectly pure and clear appearance and odor. Chemical analysis and the microscope in the hands of Prof. Nichols, of the Boston Technological Institute, completed the proof that it was much less contaminated than many waters, which are habitually drunk without damage to health. But the perfect proof consisted in the fact that several persons who drank the water did not have diphtheria, and that others who purposely avoided it were, by means of another medium of communication, affected, and some were killed. The Preston (No. 14) family as we have seen illustrate this.

It may be remarked, however, that probably not one of the houses in the district had wells, so far from various sources of contamination, as to be above all suspicion. Similar remarks may be made in regard to milk. There was no common supply of milk. Many of the families had their own cows, as farmers usually do. This confirms only what has usually been observed in regard to the influence of milk on the prevalence of diphtheria.

In conclusion, allow me briefly to enumerate the salient points of this epidemic, together with a few reflections that seem germane to the subject.

1st. We have seen the vastly greater tendency of childhood than of adult life to be affected.

But, 2d. The fact that two nursing babes escape in this epidemic, while many older children were affected, is worthy of notice.

3d. Some houses, though surrounded by the epidemic, and their inmates went among the sick, escaped, but they had only adults in them. Would it have been safe or proper for those adults to

have done so, if any children had been living with them? I should decidedly say "nay," for

4th. Adults in this epidemic have, at times, apparently carried the disease to children without having it themselves.

5th. If this epidemic does not *prove* the value of cleanliness in warding off diphtheria, it does not oppose that idea.

6th. The experience of this epidemic seems to indicate that physicians should consider the possibility of their communicating the disease in going from one patient to another. I confess that I should think it my duty to take extra precautions in regard to going from a diphtheritic patient to any other sick person without thoroughly washing my hands, and, as far as possible, disinfecting my clothing by due exposure to the air, etc. Especial precautions should be used when going from a diphtheritic case to the puerperal chamber, or that of any peculiarly sensitive patient or delicate child. Were diphtheria prevailing, and I were attending puerperal cases, I should visit all such patients before seeing the diphtheria cases, and in giving this counsel I only give that which every one will admit is correct, in case one has erysipelatous and puerperal cases to attend on the same day. For, if, in the latter hypothesis, you should go directly from dressing an erysipelatous patient to a case of labor, you would be guilty of the grossest folly; Dr. Holmes would say, crime. You would deserve the severest condemnation, because you risk the life of your patient for the sake of your own convenience, or for your fee, which is a most contemptible and reprehensible act, and one to be condemned by every honorable physician.

Future sanitary legal enactments will, I doubt not, justly hold a physician, who should be guilty of such acts, as in the cases supposed of erysipelas and labor, amenable to statute laws as much as if he administered poison, or were guilty of the grossest malpractice.

7th. On the occurrence of a case of diphtheria in a pupil, attending school, the greatest care should be taken to prevent the disease from becoming epidemic. The patient must be forthwith separated from his fellows, and kept from them, not only during his illness but for two or three weeks afterwards. He should not be allowed again to attend school until in full health, nor until all his clothing has been thoroughly disinfected. Those who have been in more immediate contact with him, just before the disease appeared, should be carefully examined, and the

question of excluding them also from the school should be decided by a medical examination. If it be evident that several children are about to be affected, the school should be forthwith closed. As many of the children as possible should be removed out of the place and kept away for several weeks, until the contaminated homesteads have been disinfected.

8th. All clothing used by a diphtheritic patient should be subjected to intense heat, either of dry air or of boiling water; and smaller rags or cloths used by such patients should be burned.

9th. Each room in which a diphtheritic patient has been ill should be thoroughly ventilated during the illness of the patient, and for a time afterwards, with thorough disinfection also.

10th. Upon the death of a patient, the body should be as soon as possible placed in a box so constructed that no effluvia can escape. The funeral should be very soon after death, and attended by the fewest possible. The neighbors and friends, and children of the family and all others should be excluded, except those needed to assist.

11th. Finally, it was suggested by one of the attending physicians, if the people of this small district had, early in the epidemic, established a temporary hospital, some lives might have been saved. A large hospital tent upon one of the adjacent hill-tops, into which every one taken ill could have been immediately transferred, would perhaps have acted, as the Bottsford homestead apparently did, viz., converted a widely prevalent and at times fatal disease into one milder and perchance non-fatal. In the depths of winter time perhaps one of the houses or even a barn might be fitted up for the same purpose.

The sum total of these suggestions comes to this result: An epidemic or a single case of diphtheria must be met very much as you would meet a case of smallpox or scarlatina, and we must try by every means in our power to limit its influence, and prevent its spread as an epidemic. I do not mean to intimate that I think diphtheria equally contagious as smallpox, but that there is a strong analogy between them, and like means should be used to prevent their spread.

I have purposely avoided quoting from other sources in regard to the question of origin and mode of transmission of diphtheria in order that we might study this special epidemic. But in

closing let me say that taking Oertel,[1] of Germany, and Armistead,[2] of England, as presenting probably the general European view of the disease, I must admit that this epidemic resembles others in not giving us exact views as to the origin of the disease; but that it confirms the opinion of its being an infective and contagious disease, which apparently may be carried in clothing as well as by contact; that it is restricted in its influence compared with other contagious diseases, such as smallpox, scarlatina; that children are more liable to it than adults; that intercourse of children with one another is a very common cause of its spreading in a community; that filth seems to make it more fatal, although cases may occur where the sanitary surroundings are not visibly imperfect; and finally, that the disease spreads slowly and is generally confined within a limited area, gathering strength with its progress in certain districts. This last feature was specially manifest in our case. A severe and fatal case occurred. A few children immediately in contact were slightly affected. It smouldered over two months and then burst out in fury; attacking almost every household, save where there was no intercourse with the sick on the part of children, but attacking them subsequently by means apparently of its infectious nature, the disease being carried by adults. After proving thus fatal it subsided, and has not attacked the adjacent country or even the neighboring city of Vergennes. At least it has not as yet done so.

Gentlemen: I do not present this report because of any new thing gained thereby, nor do I offer it as a perfect example of how this or any other epidemic ought to be investigated. But I will express my confident belief that if country practitioners throughout these States would undertake to study epidemics with the greatest detail in regard to all influences that may be supposed to promote their origin and progress, immense strides in our knowledge on these points would be gained by the whole profession. One of the fairest fields for future discovery is now opening before the young physicians of the land. Whoever will enter upon it with a sacred reverence for scientific truth, and with a determination to study facts and avoid premature inferences, will surely succeed, and thereby perchance make himself one of the benefactors of the race.

[1] Ziemssen's Cyclopædia, article Diphtheria.

[2] Proceedings of the British Medical Association, September 11, 1877.